Although this note is intended to touch on only one point of subterranean meteorology, yet it may be worth adding that the subject is a big one, and that many advances have been made in it in the last few years. It is only recently, for instance, that it has been recognized that the temperature of caves is not always the same throughout. There are many other such points which need elucidation, and the interest shown by the Weather Bureau is a welcome help to speleologists, and warrants the hope that further systematic observations and experiments will be made and more attention now be given to everything connected with the atmosphere underground.

FACILITIES FOR SYSTEMATIC STUDY OF CORRESPONDING WEATHER TYPES.[1]

BY F. H. BRANDENBURG, Forecast Official, Denver, Colo.

During the summer of 1900, it was my privilege to spend a short time in the Forecast Division of the Central Office, and in making practise forecasts for the whole United States I often felt the need of "type maps," similar to the current map, available for reference. It is needless to say that in searching for these much time was consumed without satisfactory results, and this caused me to consider seriously the matter of devising some method of classifying maps according to type. Consultation with Professor Garriott encouraged me to undertake the work, and on my return to station, plans were formulated for a system of ready reference to all weather types shown by the morning maps issued by the Central Office during the past ten years.

My purpose in bringing this subject to your attention is not to lay down any procedure for study but merely to describe facilities which it is believed will prove a valuable aid in quickly refreshing the memory as to the different conditions and types that obtain during any particular month.

The size of the original maps precludes their use, and a small base map of the United States was therefore drawn and printed on half sheets of letter paper, as shown in fig. 1, a space being reserved on the left for notations. This space is divided into two columns, at the top of which the words "high" and "low," respectively, are printed on one set, while on the other set the words of the heading are reversed. As regards the lines to be reproduced, a sketch of the principal isobars, with the regions of high and low pressure suitably marked, was considered sufficient. The period covered being about ten years, thirty-six or thirty-seven hundred maps were sketched. These sketches were duplicated by means of carbon paper, the number of duplicates for each date depending upon the number of highs and lows on the map that were considered valuable in the classification. In some instances one map was sufficient for the set of high areas and one for the set of low areas, but occasionally as many as eight in all were necessary; in general four sufficed. The next step was to outline on each small map the shaded or rainfall areas shown on the Washington map of the succeeding day. By shading these areas with a green pencil we avoid interfering with the isobars, which are drawn in red. Thunderstorms are indicated by a small green cross, and the regions visited by temperature changes of 20° are outlined in black. Mention has been made of two columns on each sheet at the left of the map. In the appropriate column an entry is made showing the location of the high and the low areas. Each of the different entries is given first place on some one map, and the distribution of the maps is made in accordance with this entry. Every map thus made finds a place in some one of the ten or eleven districts adopted. For example, let us take the high areas for January. A map for each date on which such an area occupied the British Northwest Territory will be found

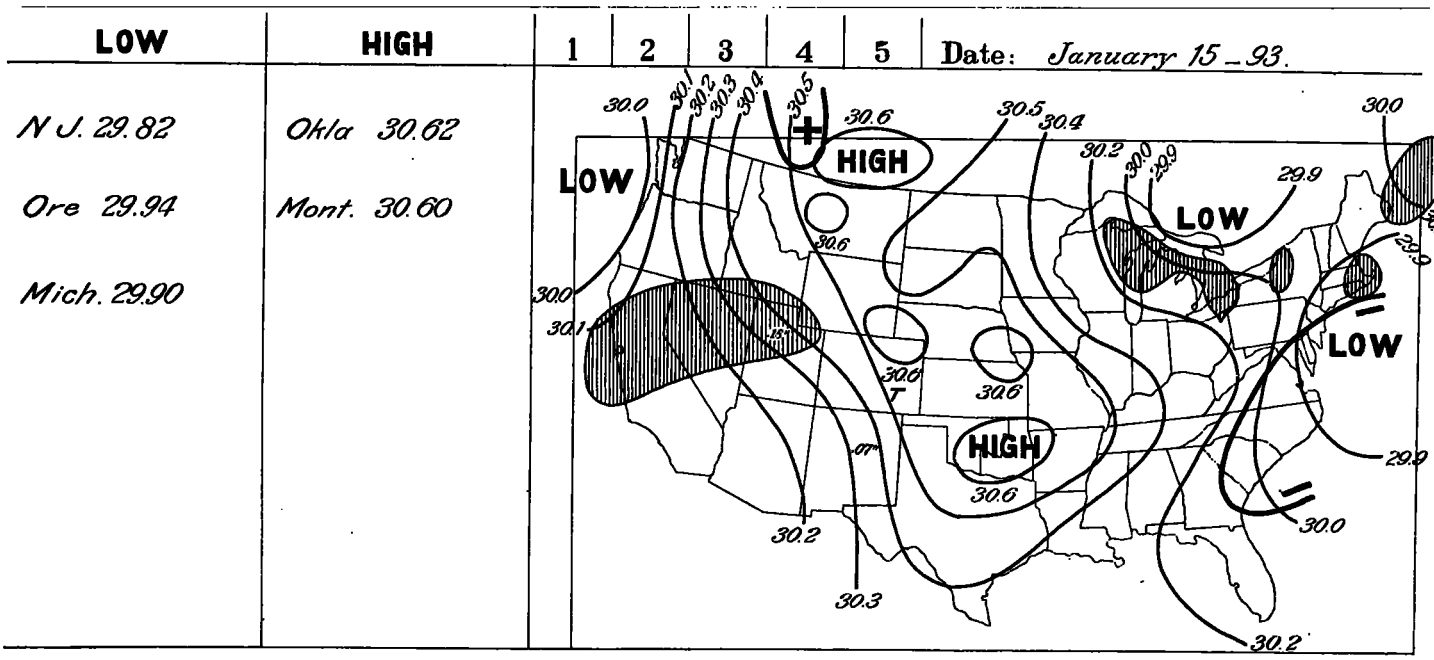

FIG. 1.—Sample map for classified file.

[1] Read before the Milwaukee Convention of Weather Bureau Officials, August 28, 1901.

in its appropriate subdivision, and the same is true of any other high area, no matter in what part of the United States it is located. In the subdivisions the maps are arranged according to type, and the total number of dates, as indicated by the number of maps, shows at a glance the prominent features of the pressure distribution for all past Januaries. Arranged in two small boxes, highs in one and lows in the other, with cards to indicate the different subdivisions, it is a matter of only a few moments to learn whether any particular type of map is rare or common during January and whether pronounced conditions follow.

Since the Washington maps must be referred to for information as to the conditions that obtained *more* than twenty-four hours after, it is very desirable that they be conveniently arranged. It has been found best to bind three months, say January, 1892, 1893, 1894, in one cover, thus making only three or four books for the entire period. Study of the temperature is facilitated if the changes as shown by the table on the map of the next day are written near the respective stations on the map under consideration. As the number of stations with changes equaling or exceeding the stationary limit is small as a rule, one is well repaid for the work of entering the data, red figures being used to indicate plus changes, and blue figures minus changes.

Since the current distribution of pressure, and whatever important conditions it brought about as regards temperature and rainfall, are graphically shown on each small map, I am of the opinion that the use of this system will facilitate the study of all types and will necessarily cause a general improvement in the daily forecasts; for no mind is capable of retaining without constant study a clear impression of the weather changes peculiar to each of the twelve months in the different topographical divisions of the United States.

A PROPOSED CLASSIFICATION AND INDEX OF WEATHER MAPS AS AN AID IN WEATHER FORECASTING.

By PROF. W. V. BROWN, Voluntary Observer, United States Weather Bureau, De Pauw University.

The writer has, since August 1894, been preserving the daily weather maps issued by the Indianapolis office of the Weather Bureau. They now constitute a file of nearly twenty-two hundred, and are arranged in a purely empirical system of classification which serves to bring together maps that present the same distribution of barometric conditions. The method of classification, together with an index of the maps, enables one to immediately find a map presenting any given combination of highs and lows, together with all maps bordering on the required one, and also the map of any given date.

The formation of the file was undertaken in the hope that a certain degree of uniformity might be found in the sequence of the maps belonging to any type.

Weather conditions are almost kaleidoscopic, yet in the twenty-two hundred maps there are found a great many instances where a type recurs several times, the maps of the different dates bearing a very close resemblance to each other.

It seems not unreasonable, in those cases where approximately identical conditions have been restored, to expect that like conditions would produce like effects, and the maps of the next succeeding day would, in each instance, also show resemblances.

This idea must not be pushed too far, or the attempt be made to prove too much. This paper has no reference to any cycle or periodicity in the weather, and no hypothesis is to be advocated; but the claim is made that in the file described above there is abundant evidence that when a condition or type does, through any causes whatever, recur, there is a tendency toward similarity in the maps next following; this similarity sometimes persists for three or four days before being gradually lost, it sometimes extends to the most minute and exact degree, and in any case it ought to be reckoned with in the making of weather predictions.

I understand that Mr. F. H. Brandenburg, Forecast Official in charge of the Weather Bureau office at Denver, read a paper before the Milwaukee Convention on this same subject. As Mr. Brandenburg's paper has not yet appeared in print I am unable to judge how far we have worked on the same problem, or on parallel lines.

In illustration of the proposition advanced above, three cases are submitted, involving, respectively, precipitation, change of temperature, and a cold wave. These are not given as the best instances found, but are simply three out of the first five or six types that have been studied.

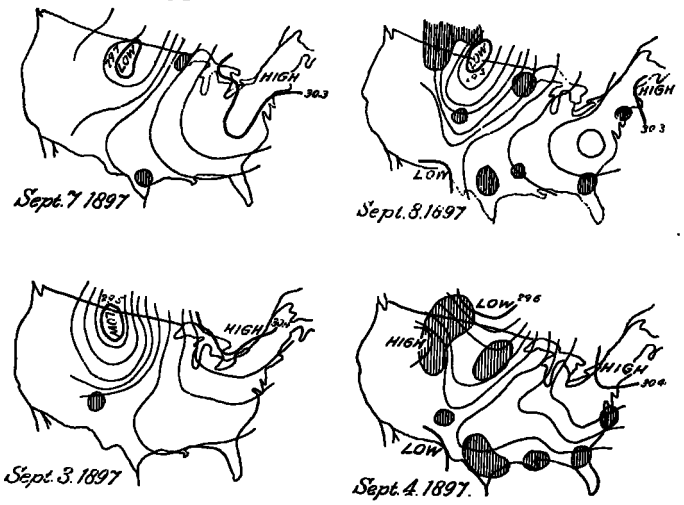

FIG. 1.—Precipitation types.

In fig. 1 we find on September 7, 1897, an approximate repetition of the conditions of September 3, and attention is called to the duplication on September 8 of the map of September 4. There is in each case a low north of Dakota, a second low south of Arizona, a high over northeastern New England, and seven rain areas alike in distribution and magnitude, (the far Northwest, the western point of Lake Superior, the middle slope of the Rocky Mountains, Texas, the vicinity of New Orleans, Jacksonville, and the middle Atlantic coast).

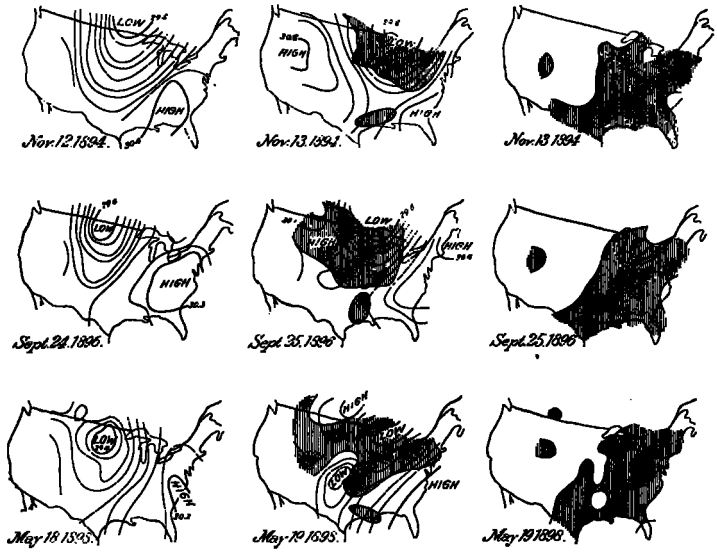

FIG. 2.—Pprecipitation and temperature types.

Fig. 2 gives, in the first vertical column, the maps of the